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Impact of Farmers' Cooperative Membership on Smallholder Farmers' Income in Rural East Gojjam Zone

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Abstract

In Ethiopia, cooperatives are crucial for distributing agricultural inputs and reducing production constraints. They also offer financing services to member farmers, which enhances livelihoods, reduces rural poverty, and boosts food security. Agricultural cooperatives are essential for obtaining financial resources, stabilizing consumer prices, securing agricultural inputs at fair prices, and giving a voice to the impoverished. The primary objective of this study was to investigate the impact of cooperative membership on farmers' income in East Gojjam Zone. Cross-sectional data were collected from 371 smallholder farmers in Aneded District using a multi-stage sampling procedure and probability proportional technique. Various statistical methods such as binary logistics regression and propensity score matching models were used to analyze the data. The binary logit model identified key factors influencing smallholder farmers' participation in agricultural cooperatives, while propensity score matching assessed the impact of cooperative membership on farmers' income. Income inequality was examined using the Gini coefficient and Lorenz curve. The study found that gender, education level, farm activity, and access to training significantly influenced farmers' participation in cooperatives positively and distance influenced farmers' participation in cooperatives negatively and significantly. Results from propensity score matching indicated that cooperative membership significantly increased total income but also worsened income distribution. Specifically, income inequality, as measured by the Gini coefficient, increased from 0.2603 to 0.2729 after joining cooperatives. The findings suggest that awareness creation measures are necessary to improve smallholder farmers' participation in agricultural cooperatives. Stakeholders in the study area should focus and give primary attention on these measures to enhance the benefits of cooperative membership while addressing the issue of income inequality.

Keywords: Agricultural cooperatives, East Gojjam Zone, Farmers' participation, Smallholder farmer.

1. Introduction

Millions of people around the world are still living in poverty, which prevents them from

improving their lot in life. Cooperatives have become a realistic option for economic empowerment in this difficult situation, when reducing poverty is still a major concern for humanity. Cooperatives encourage cooperation between people in order to meet shared needs. They are predicated on the idea that a team may accomplish objectives that would be impossible for an individual to accomplish alone (Eshetie & Sisay, 2018). Cooperatives, for instance, have been demonstrated to make a substantial contribution to socioeconomic development through raising income, generating employment, and fostering social interaction. Additionally, they are essential in empowering communities by giving them access to opportunities and resources, especially in rural areas (Eshetie and Sisay, 2018; Ruhul and Mohammed, 2014).

Cooperatives serve as agricultural input providers, disseminate improved agricultural technologies, compete with private traders to enable higher prices of agricultural commodities, drive income gains for farmers through value addition, and provide marketing alternatives. Recognizing the roles cooperatives play in bringing smallholder farmers together and contributing to sustainable local-level development for their members and beyond, governments around the world devise and implement policies and strategies to support cooperative development (Ararssa, 2016).

According to International Cooperative Alliance (ICA, 2016), almost one billion individuals are either employees, members, or both in cooperatives. According to the same statistic, cooperatives globally provide work opportunities for around 280 million individuals. Cooperative businesses protect nearly half of the world's population's means of subsistence. This is especially true in rural regions, where it offers residents significant opportunities for equity and income development. The efforts of the Federal Cooperative Agency (FCA) have resulted in considerable growth in both the number of agricultural cooperatives and the services they provide to their members (Abate et al., 2014). According to Bernard et al. (2013), in Ethiopia there were 6.5 million members in 43,256 main cooperatives in 2012, of which 26.5% were agricultural cooperatives. Of them, 21.5% were female. In Ethiopia the number of primary agricultural cooperatives increased from 6825 in 2008 to 15,568 in 2014 (FCA, 2015).

In Ethiopia, cooperatives play a major role in the distribution of agricultural inputs; in the 2010 growing season, cooperatives supplied almost 56% of the chemical fertilizers. To reduce production constraints, cooperatives can also offer member farmers financing services (Tefera et al., 2016). Enhancing farmers' livelihoods, lowering rural poverty, and boosting food security all depend on this increase in agricultural output (Zeng et al., 2015). In order to obtain financial resources, stabilize consumer prices, obtain agricultural input at fair prices, and provide the impoverished a voice, agricultural cooperatives are now understood to be essential tools (FCA, 2016).

According to Nuradin's (2015), the role cooperatives in economic development were affected by backward mindset, lack of dedicated leadership, poor governance, lack

of working capital, corrupt mindset and practice, lack of knowledge and expertise, lack of access and use of improved technology, weak vertical and horizontal links within and among cooperatives and improper support from the government and other stakeholders.

Furthermore, despite the various obstacles that smallholder farmers in Ethiopia face when trying to participate in farmers' cooperatives, the research done to address these issues is insufficient, and the findings of these studies conflict with one another. They were conducted in general case that refers to agricultural cooperative. Finally, they have their own difficulties, such as accessibility and awareness of society. Therefore, this study intends to fill this gap by investigating the main factors that affect smallholder participation in primary multi-purpose farmers' cooperative and their impact on the income of smallholder farmers.

Based on the above-identified gaps, the following research questions are forward: What are the factors determining smallholder farmers' participation in primary multi-purpose farmers' cooperatives Rural Ethiopia? What are the impacts of primary multi-purpose farmers' cooperative membership on smallholder farmers' income in Rural Ethiopia? What are the effects of primary multi-purpose farmers' cooperative membership on smallholder farmers' income inequality in Rural Ethiopia?

The empirical findings highlight that demographic factors (age, sex, and education), social participation, economic, and institutional factors influence farmers' participation in agricultural cooperatives significantly. However, no prior studies have examined these factors in the study area. This research explores the impact of cooperative membership on smallholder income and income inequality using propensity score matching and the Gini coefficient/Lorenz curve. It aims to fill this gap and encourage further studies. The conceptual framework identifies key variables influencing participation, including age, marital status, education, attitude, income, farm activity, access to credit, and other factors.

2. Materials and Methods

As illustrated in Figure 1, this study was conducted in Aneded District, one of the sixteen Districts in the East Gojjam zone within the Amhara regional state. The capital of Aneded District is Amber, which is 260 km from Addis Ababa and 20 km from Debre Markos, the capital of the zone. The district comprises twenty kebeles[1], nineteen of which are rural and one urban. Aneded district is bordered on the South by the Abay River, which separates it from the Oromia Region, on the Southwest by Baso Liben, on the Northwest by Guzamn, on the North by Sinan, and on the East by Awabel (CSA, 2007).

To address the research questions, an explanatory research design was employed. The study used primary sources of data. The main data collection technique used in the study was a questionnaire.

The study targeted smallholder farmers, including members and non-members of

[1] Kebele, is the smallest administration unit in Ethiopia.

agricultural cooperatives, to examine factors influencing participation in primary multi-purpose cooperatives. A multi-stage sampling method was used: initially, rural kebeles were stratified by proximity (near and far); next, farmers within each kebele were divided into cooperative members and non-members; finally, a sample of 371 farmers (193 member and 178 non-member) was selected based on Kothari (2004) formula, ensuring a 5% margin of error and 95% confidence level from a total population of 10,773 eligible farmers aged 18 and above (Federal Negerit Gazette No. 7, 23nd, 2016, p-9458).

$$n = \frac{z2.p.(1-p).N}{e2(N-1)+ z2.p.q} = \frac{(1.96)2(.0.5).(1-0.5).(10773)}{(0.05)2(10773-1)+(1.96)2.(0.5).(0.5)} = 370.9659\sim371$$

The effect of farmers' cooperative membership on the income of farmers using a propensity score matching model. Finally, we analyze the effect of farmers' Agricultural cooperative membership on income inequality before and after matching among smallholder farmers by calculating the Gini coefficients and drawing the Lorenz curve.

The Propensity Score Matching (PSM) model, introduced by Rosenbaum and Rubin (1983), offers a more accurate approach for estimating treatment effects compared to traditional models. By employing a non-parametric method to balance covariates between treatment and control groups, PSM reduces bias and enhances causal estimates, especially in cases where missing data complicates impact assessment. In this study, a logit model was used in the initial step to calculate propensity scores, given its mathematical simplicity and effectiveness for dichotomous variables. Here, the dependent variable identifies agricultural cooperative members (1) and non-members (0), enabling a clearer, unbiased estimation of the intervention's impact (Gujarati, 2004).

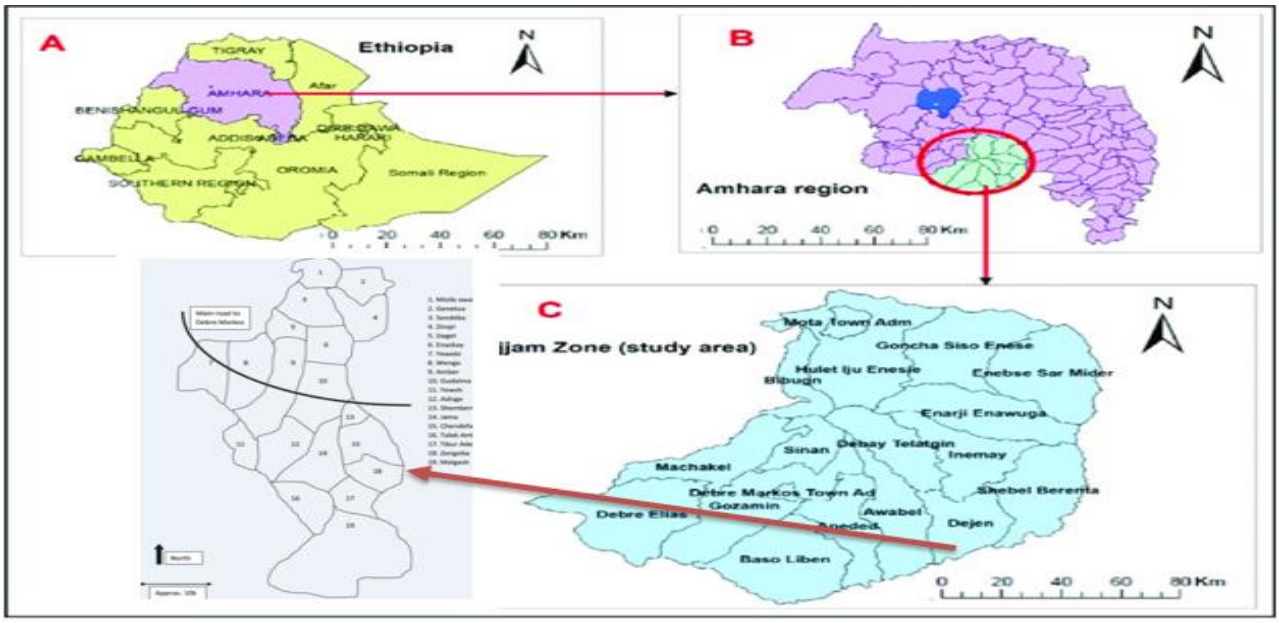

Figure 1. Map of the study area

Source: Ethiopian GIS, 2024

Table 1. Proportional sample size determination

No.	Kebele name	Number of populations	Sample size
1.	Gudalema	4239	146
2.	Mislewash	2588	89
3.	Talak amba	2527	87
4.	Tikur adbr	1419	49
	Total	10,773	371

The binary logistic probability model is econometrically specifying as follows:

$Pi = E(Y = 1/Xi) = \frac{1}{1+e-(\beta 0+\beta 1Xi)}$…… (1)

In the logistic distribution equation, Pi is the probability of a farmer to be a member; Xi is the data that is the possibility of a preference by an individual (option of having 1 and 0 values). When β1+β2Xi in Equation 1 is replaced by Zi, Equation 2 is obtained:

$Pi = \frac{1}{1+e^{-zi}}$ ……(2)

Zi is between -∞ and +∞, and Pi is between "1" and "0". When Pi shows the possibility of a member, the possibility of non-members farmers is 1- Pi. Then, the possibility of non-member can explain as in Equation 3 as follows:

$1 - \frac{1}{1+e^{-zi}}$=1–Pi…… (3)

Equation 4 is obtained by dividing the members by non-members:

$\frac{Pi}{1-Pi} = \frac{\frac{1}{1+e^{-zi}}}{1-\frac{1}{1+e^{-zi}}} = \frac{1}{e-zi} = e^{zi}$……(4)

Now $(\frac{Pi}{1-Pi})$ is simply the odd ratio which is the ratio of the probability that a given farmer being a participant in farmers' agricultural cooperative to the probability that it will not being a participant in farmers' agricultural cooperative.

Finally, taking the natural log of equation (5), we obtain:

$Li = \ln(\frac{Pi}{1-Pi}) = Zi = \beta 0 + \beta 1Xi + \text{---} + \beta nXn + Ui$…… (5)

Where Pi is the probability of being a member of farmers' agricultural cooperative range from "0" to "1". Zi is a functional explanatory variable (X) which is also expressed as:

$Zi = \beta 0 + \beta 1Xi + \text{---} + \beta nXn$…… (6)

Bo is an intercept

B1, B2 --- Bn are slopes of the equation in the model.

Li is the log of the odd ratio

Xi is the vector of farmers‟ characteristics.

Ui = Error term

Odds and odds ratio are significant terms in the logit model. Odds are defined as the ratio of the number of events that occurred to the number of events that did not occur. "Odds ratio" on the other hand, is the ratio of two odds, in other words, the ratio of

likelihood to another. In Equation 4, two probabilities, members' and non-members' probability of an event are proportioned and this is the odds of proportion. It is important to understand that possibility, odds, and logit concepts, are three different ways of explaining the same thing (Menard, 2002).

Additionally, the marginal effect will calculate to show the actual impact of each variable on the probability decision. The marginal effect captures changes in the predicted probabilities as the binary independent variable changes from 0 to 1 when all other variables equal their means. Similarly, it shows how much the response variable changes with a unit change in one continuous independent variable, maintaining other independent variables constant.

$Zi = \beta_o + \sum \beta iXi + Ui$…… (7)

Where: Zi is the probability of an individual participating in a farmers' cooperative (PPFc); β is a parameter of the explanatory variable.

y = 1, an individual participates in farmers' cooperative

y = 0, otherwise

Xi = vector of explanatory variables

Ui = Error term

The error term "U" contains many important determinants of farmers' cooperatives, which are ignored. Which is out of the researcher's scope.

The effect of membership on the income of farmer's will be investigated by letting V = 1and V = zero, be the amount of income for participants and non-participants respectively. As such, the difference in outcome between treated and control groups can see from the following mathematical equation:

$\partial = V_1 - V_0$ ……(8)

V_1= Outcome of treatment (income of the member farmer, when he or she accesses to services provided by farmers' cooperative). V_0 = Outcome of untreated farmers (income of the non-member farmers, when he or she does not access services provided by farmer cooperative). ∂ = Change in outcome due to treatment.

Equation (9) is then expressed in causal effect notational form by assigning T =1 as a treatment variable, taking the value 1 if an individual received the treatment and 0 otherwise. Then, the Average Treatment Effect of an individual can be written as:

$ATE = E\ (V_1|T = 1) - (V_0\ |T = 0)$ .....(9)

Where: ATE, Average Treatment Effect: is the effect of treatment on farm income.

$E\ (V_1|T = 1)$: Average outcomes for farmer with treatment, if he or she chooses to accesses to services through farmer cooperative,(T = 1) $(V_0\ |T = 0)$: Average outcome of an untreated farmer, when he or she does not access accesses to services through farmer cooperative, (T = 0). Furthermore, the Average Effect of Treatment on the Treated (ATT) for the sample can be measured as:

$ATT = E\ [(V_1 - V_0, P(x))] = E\ (V_1\ |T = 0, P(x)) - E\ (V_0\ |T = 0, P(x))$…… (10)

Table 2. Summary of explanatory variables

Variable	Possible short Form	Description	Expected signs.
Educational level	EDUL	EDUL = 1, if literate, otherwise 0.	+
Age (year)	AGE	Continuous	+/-
Gender	GEN	Gen = 1, If the respondent is male, otherwise 0.	+
Marital status	MARTS	MARTS = 1, if married, otherwise 0.	+/-
Farm experience (year)	FARMEXP	Continuous	+
Access to market	ACCMKTINF	"1" if a respondent has market access, "0" otherwise.	+
Off-Farm activity	OFF-FARM	Takes a value of "1" if farmers participate on off-farm activity and "0" otherwise.	+
Farm Land Size(heactar)	FARMLSIZE	Continuous	+
Distance from the farmers' cooperative office (km)	DFC	Continuous	-
Income (annually in ETB)	INC	Continuous	+
Access to training	ACCTRN	"1" if there is access to training, "0" otherwise.	+
Attitude of respondent on farmers' cooperative	ATT	Att = 1, If attitudes of the respondent on farmers' cooperative are good, otherwise 0.	+
Number of Livestock	LIU	Continuous	+
Access to credit	ACCCREDIT	"1" if there is access to credit, "0" otherwise.	+

Source: Researcher's own formulation (2023)

The performance of the matching exercises was evaluated using three diagnostic tests. These are:

Perform balancing tests: Participants and non-participants should have balanced covariates. Comparison of standardized bias (difference in means ÷ standard deviation) before and after matching: lower after matching. Joint significance (likelihood ratio tests): insignificant after matching; Psuedo-R2: lower after matching (Rosenbaum and Rubin, 1983).

Lastly, for the two scenarios, separate computations of the Lorenz curves and Gini coefficients were made. The distinctions between the two, which are based on counterfactual income distributions and observable income distributions, show how membership affects income disparity. The following formula was used to determine the Gini coefficient:

$$\text{Gini Coefficient} = \sum_{i=0}^{n} \frac{(2i-n-1)Xi}{\sum_{i=0}^{n} Xi}$$

Where: Xi = individual level of income
i = rank value of individuals
n = number of observations

3. Results and Discussion

In this section, we examine the empirical factors that determine smallholder farmers' participation in primary multipurpose farmers' cooperative within the study area. Logit regression analysis was employed for estimation purposes. The dependent variable, 'membership status, is a function of several independent variables. The major independent variables, including the dependent variable, are described below.

Table 3, represents a comparison of cooperative members and non-members across various socioeconomic and demographic variables, along with their statistical significance. Gender distribution is nearly balanced across both groups, with a slightly higher percentage of females among non-members. However, the chi-square test suggests no significant difference. Similarly, marital status does not show a significant impact on membership status. Education level, however, is highly significant**,** indicating that literate farmers are more likely to be cooperative members. Attitude towards participation and access to credit show no strong statistical association, though members tend to have a more positive attitude. Off-farm activity and access to training are significantly associated with membership, suggesting that those engaged in off-farm activities and those who receive training are more likely to join cooperatives. Among continuous variables, farm experience and farmland size are significantly higher among members, suggesting these factors influence cooperative participation. Distance from the cooperative is higher for non-members but lacks statistical significance. Overall, education, training access, off-farm activity, and experience significantly influence cooperative membership.

Before estimating the Binary logit model, key econometric assumptions were tested to ensure model reliability. The researcher checked for omitted variable bias and model specification errors. The result, confirming that the model had no omitted variables or specification errors. Goodness-of-Fit (Hosmer-Lemeshow Test) the result, indicating a good model fit. This suggests that the explanatory variables sufficiently explain variations in the dependent variable. Multicollinearity Test variance Inflation Factor (VIF) was used for continuous variables, and Contingency coefficient (CC) analysis for dummy variables also showed no multicollinearity issues. Heteroscedasticity Test the Breusch-Pagan/Cook-Weisberg test shows the absence of heteroscedasticity, meaning error variances are constant across observations (Appendix I).

From the above table 4, the regression result of the model shows that the model was overall significant statistically at 1% level of significance or 1% margin error because the probability of the model was less than 1% (i.e. prob>chi2 = 0.0000<0.01). Chi2-value of 0.0000 indicates strong statistical significance, which enhanced the reliability and validity of the model. The logit estimates of the membership equation correctly predict 75.17% members and 74.16% of non-members which altogether had 75.20% correctly classified observations.

Table 3. Summary of variables by Membership status

Variable		Membership status			
		Members (N = 193)	Non members (N = 178)	Total (N= 371)	χ2 –value/t-value
Gender	Male	54.4%	46.6%	50.7%	2.2416
	Female	45.6%	53.4%	49.3%	
Marital status	Married	51.3%	56.2%	53.6%	0.8889
	Single	48.7%	43.8%	46.4%	
Level of Education	Literate	68.9%	35.4%	52.8%	42.5361***
	Illiterate	31.1%	64.6%	47.2%	
Attitudes of respondent toward participate	Good	60.1%	52.2%	56.3%	2.3248
	Bad	39.9%	47.8%	43.7%	
Farm activity	Yes	57.0%	45.5%	51.5%	4.9036**
	No	43.0%	54.5%	48.5%	
Access to credit	Yes	56.0%	48.3%	52.3%	2.1705
	No	44.0%	51.7%	47.7%	
Access to training	Yes	65.3%	33.7%	50.1%	37.5739***
	No	34.7%	66.3%	49.9%	
Access to market information	Yes	56%	59.6%	57.7%	0.4897
	No	44%	40.4%	42.3%	
Age		40.3(1612)	41.2(15.6)	40.7(15.8)	0.5492
Farm experience		19.7(13.6)	15.2(12.4)	17.5(13.2)	-3.3189***
Annual income		41327	39727	40559	-0.8052
Farmland size		1.06	0.76	0.91	-3.525***
Livestock holding		8.1	8.6	8.3	0.5817
Distance from the farmers' cooperative		7.95	11.16	9.49	3.7586

Source: own field survey, 2023

Table 4. Maximum likelihood estimates of the Binary logit model

Explanatory variable	Estimated coefficient	Odds ratio	Standard error	P>|z|	Marginal effect
Age	0.005	1.005	0.008	0.510	0.001
Gender (female = 0)	0.513**	1.670	0.248	0.039	0.127
Educational level(0=illiterate)	1.452***	4.273	0.256	0.000	0.347
Marital status (0 = single)	-0.398	0.671	0.248	0.108	-0.099
Farm land size	0.196	1.216	0.19	0.302	0.049
Annual Income	5.25e-06	1.000	6.82e-06	0.442	1.31e-06
Access to training (0 = no)	1.390***	4.018	0.253	0.000	0.333
Access to credit (0 = no)	0.159	1.172	0.250	0.524	0.040
Farm experience	0.012	1.012	0.012	0.330	0.003
Market information (0 = no)	0.140	0.869	0.249	0.573	0.035
Distance	-0.052***	0.949	0.015	0.001	-0.013
Off-Farm activity (0 = no)	0.539***	1.714	0.251	0.032	0.134
Attitude (0= bad)	0.323	1.381	0.253	0.203	0.001
Livestock unit	0.002	1.003	0.012	0.860	0.003
Cons	-3.225	0.171	0.698	0.005	___
Hosmer-Lemeshow goodness of fit Chi2 ($\widehat{H}\ \chi 2$ (8)) = 10.07 Prob > chi2 = 0.2600					
Sensitivity 76.17% No of observation 371 Pseudo R2 0.2154	Specificity=74.16%	Correctly classified LR chi-square Log likelihood		(P-value)	75.20% 110.66(0.0000) -201.5265

*** = statically significance at 1% and ** = statically significance at5%.

Source: STATA (14) output, 2023

The model was statistically significant, but not all variables were. Gender, education, farm activity, and training positively affected membership, while distance negatively affected it. Other factors were statistically insignificant.

In terms of marginal effect, the model is:

MEMBERSHIP STATUS = 0.001AGE - 0.099MARS + 0.127GEN – 1.31e -0.6INC + 0.049FARMLSIZE + 0.003FARMEXP + 0.080ATT – 0.013DFC + 0.347EDULD + 0.001LIU - 0.035ACCMKTINF + 0.333ACCTRN + 0.04ACCCREDIT + 0.134FARMAC

Gender is one of the variables that can explain smallholder farmers' membership

status in primary multipurpose farmers' cooperative. The econometric results show a positive and significant relationship between the gender of the respondents and the decision to participate in farmers' cooperative at the 5% significance level. The marginal effect is 0.127, meaning that being male smallholder farmers increases the probability of participating on agricultural cooperative by 12.7%, other factors keeping constant.

Education significantly enhances smallholder farmers' ability to communicate, access information, and adopt new technologies. Binary logit regression results reveal a strong positive correlation between farmers' educational levels and their participation in cooperatives, with literate farmers 34.7% more likely to join. This increase reflects educated farmers' have better understanding of cooperative benefits, greater access to information, and openness to new agricultural technologies, leading to higher productivity. Previous studies also support this finding (Bernard & Spielman, 2009).

Training helps enhance human capabilities by improving the level of thinking and ways of life. The same is true for improving farmers' participation status in agricultural cooperatives. This variable is significant at the 1% level and is positively associated with participation status in agricultural cooperatives. keeping all other factors constant, on average, the probability that, smallholder farmers who participating in training are 33.3% more likely to join Agricultural cooperatives that smallholder farmers not farmers participating in training. This was similar in Ararsa (2016).

Off-farm activity is a significant factor influencing farmers' participation in agricultural cooperatives. This variable is significant at the 5% level and is positively associated with participation status in agricultural cooperatives. All other factors being constant, on average, the probability that, smallholder farmers who engage in off-farm activities are 13.4% more likely to join cooperatives that smallholder farmers not engaged in off-farm activity.

The results indicate that being closer to the cooperative office greatly increases the chances of joining an agricultural cooperative. When the office is closer, farmers save time and labor, enhancing communication and knowledge about cooperative benefits. This variable, significant at the 1% level, shows that each additional kilometer from the office reduces a farmer's membership probability by 1.3%. This is similar in (Francesconi & Heerink, 2010, Musa & Hiwot, 2017).

At the end of the Binary logit model estimation, different diagnostics tests were performed to ensure that the mode for farmers participating in agricultural cooperative is valid and reliable. The first test performed was heteroskedasticity test given by the Breusch-Pagan/Cook-Weisberg test. Since its p-value is greater than 0.05 it shows absence of heteroscedasticity problem, suggesting the error variances are constant across observations Secondly, the researcher checked for omitted variable bias and model specification errors. Since, the coefficient of **hatsq** is not significant, the result confirm that the model had no omitted variables or specification problem and hence

the model is specified correctly (see Annex 1 for the results).

Thirdly, the Hosmer-Lemeshow goodness of fit statistics ($\widehat{H}$) was computed after estimating the coefficients included in Binary logit model. As can be seen in the lower panel of table 4, the results indicate that goodness of fit is $\widehat{H}$ $\chi 2$ (8) = 10.07. And the corresponding P-value computed from the chi square distribution with 8 degree of freedom is 0.2600, which is insignificant. These results indicate that the binary logistic model fit quit well for the purpose because there is no significant difference between the observed and expected data. Finally, the classification test based on the Binary Logistic regression model using a cut-point 0.5 indicates that the overall rate of correct classification is estimated to be 75.2%. Whereas, the proportion of successful farmers membership of in agricultural cooperative that are correctly classified (sensitivity) is 76.17%. That is, of the total 193 farmers who reported that indeed they are member of agricultural cooperative in their Woreda about 147 of them were correctly predicted (i.e. sensitivity =147/193=76.17%). On the other hand, the percentage of correctly classified farmers that are not a member of agricultural cooperative (specificity) is 76.14% (132/178).

Next to applying the estimated logit model, propensity scores were predicted for each smallholder farmer. The results of the predicted propensity scores suggested a region of common support of [0.0582236, 0.9561123], where only two (0.53%) out of 371 respondents were out of the common support. As indicated in figure 2, the common support condition was satisfied because there was considerable overlap in the distribution of the propensity scores of both member and non-member groups.

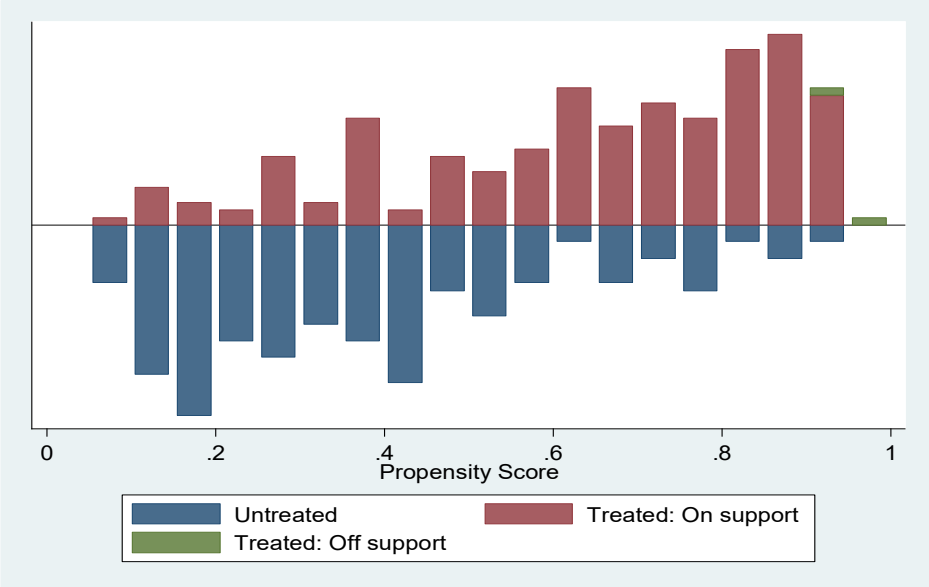

Figure 2. Histogram for Propensity score distribution and common support

Source: Own field survey (2023)

The first step in estimating the impact of cooperative membership, the quality of alternative matching algorithms was checked based on the mean standardized bias, pseudo R2, and likelihood ratio tests before and after matching. As shown in Table 3, the mean standardized bias was 26.6% before matching and was reduced to 9.7% to 6.9%, with a substantial reduction in standardized bias ranging from 63.5% to 74.06%. The pseudo R2 was 21.3% before matching and decreased from 3.0% to 2.0%. Moreover, the likelihood ratio tests show the joint insignificance of covariates after matching, whereas it is significant before matching. Hence, the decrease means standardized bias, increase total reduction of bias, decrease pseudo R2, and insignificant p-values of the likelihood ratio test after matching suggest that the PSM procedure is reasonably successful.

Table 5. Covariate balance indicators before and after matching

Matching algorithm	**NNM-1**	**NNM-5**	**KBM-0.03**	**KBM-0.06**
Mean std. bias (before)	26.6	26.6	26.6	26.6
Mean std. bias (after)	9.7	6.9	9.7	9.7
Percentage of bias reduction	63.5%	74.06%	63.5%	63.5%
Pseudo R2 (before)	0.213	0.213	0.213	0.213
Pseudo R2 (after)	0.031	0.020	0.031	0.031
LR χ 2 with p-value (before)	109.30 (0.000)	109.30 (0.000)	109.3 (0.000)	109.3 (0.000)
LR χ 2 with p-value (after)	16.30 (0.234)	10.44 (0.658)	16.30 (0.234)	16.30 (0.234)

NNM-1: Nearest neighbor matching with single neighbors.
NNM-5: Nearest neighbor matching with five neighbors.
KBM-0.03: Kernel based matching with 0.03 bandwidth.
KBM-0.06: kernel-based matching with 0.06 bandwidth.
Source: Computed using survey data (2023)

The effect of smallholder farmers' participation in farmers' cooperative on income is estimated after checking the matching quality of the different algorithms. Table 4 presents the results.

Table 6. Impact of cooperative membership on smallholder farmers' income

Matching algorithm	**ATT**	**Std. err.**	**t-stat**
NNM-1	6960.40	3176.2	2.19**
NNM-5	4863.67	2988.35	1.63
KBM-0.03	6960.40	3176.2	2.19**
KBM-0.06	6960.40	3176.2	2.19**

Note: ** and * indicate significance at the 5% and 1% level, respectively.

Source: Computed using survey data (2023)

The analysis found that participation in farmers' cooperatives had a positive and significant impact on smallholder farmers' income, with members earning 6,960.40 birr more than non-members according to alternative matching algorithms. However, cooperative membership also appeared to increase income inequality. The Gini coefficient for members was 0.26770, slightly higher than the 0.26033 for non-members, suggesting that while cooperative membership raises income levels, it may also lead to a more unequal distribution of that income.

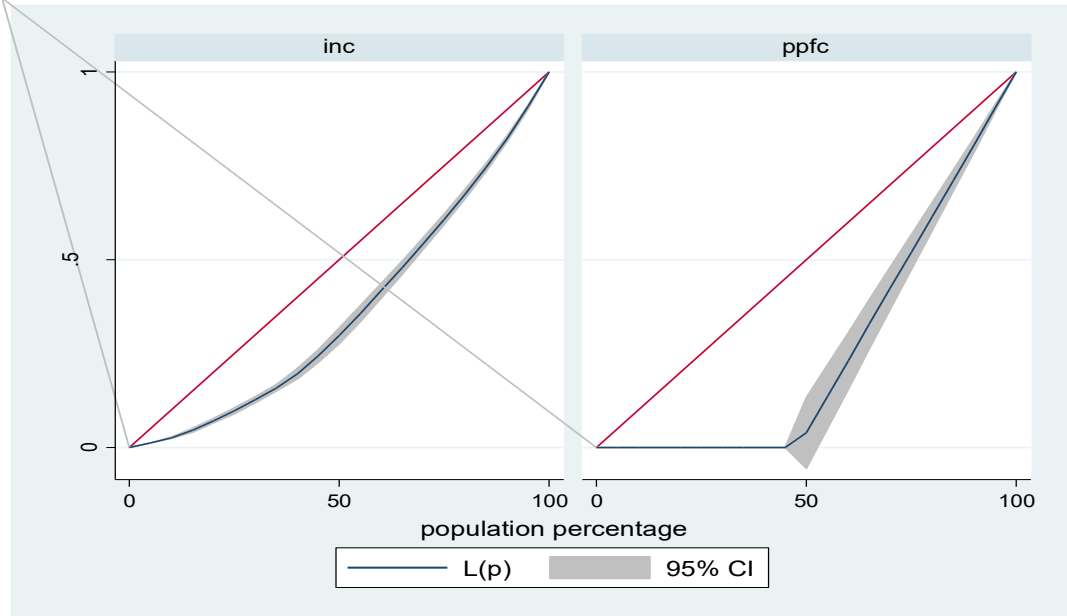

Figure 3. Lorenz curve

Source: Computed using survey data (2023)

The Lorenz curve is important because it represents one of the simplest ways to illustrate the level of economic inequality in society. The Lorenz curve is a graphical representation of the distribution of income and wealth in a society. The farther the curve moves from the baseline, represented by the straight diagonal line, the higher is the level of inequality.

From Figure 3, the left panel (Income) shows a Lorenz curve that closely follows the 45-degree line but still bows downward, indicating some income inequality. The right panel (the membership status) exhibits a much steeper bowing, especially for lower population percentages, implying greater inequality. The justification here is that the saving & credit status variation among members within many years may bring the income inequality.

4. Conclusion and Recommendation.

Binary logit analysis showed that gender, level of education, distance from the farmers' cooperative, access to training, and off-farm activity significantly affected the membership status of smallholder farmers. Age, marital status, access to market

information, and annual income affected the membership status of smallholder farmers negatively, but insignificantly, at all levels of significance. Farmland size, farm experience, Attitudes, tropical livestock unit and access to credit affected the membership status of smallholder farmers' positively but, statistically insignificance at all level of significance.

Using propensity score matching, the effect of membership in agricultural cooperatives was calculated. By accounting for the issue of self-selection in joining decisions, this aids in estimating the actual revenue impact of agricultural cooperative membership. According to these results, agricultural cooperatives are successful in raising rural communities' incomes. According to the effect estimation derived from propensity score matching, members of agricultural cooperatives earn substantially more than non-members. But at the same time, it made the income distribution worse, suggesting that large farmers gained more from agricultural cooperative membership than did small farmers.

Promoting improved technologies that reduce the domestic burden on female smallholder farmers would improve their level of participation in primary agricultural cooperatives. Stakeholders at different levels of management should focus on enhancing farmers' education levels through adult education. The educational level of smallholder farmers should be increased through training and awareness creation to enable them to be more active and effective members of primary multipurpose farmers' cooperative. Based on economic viability, cooperative promotion agencies should focus on addressing and assisting those who live far from their office, and the government should make roads more accessible. There should be more efforts made to encourage smallholder farmers to join farmers' cooperatives. At the same time, appropriate steps should be made to ensure that smallholder farmers receive a fair share of the advantages of membership. Therefore, by offering formal education and making training and cooperative services more accessible to smallholder farmers, the government and other relevant authorities should concentrate on enhancing smallholder farmers' participation in farmers' cooperatives.

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Appendix- I

Conversion factors used to estimate tropical livestock unit

Animal Category	TLU
Calf	0.25
Donkey (young)	0.35
Weaned Calf	0.34
Camel	1.25
Heifer	0.75
Sheep and goat (adult)	0.13
Cow and ox	1.00
Sheep and goat (young)	0.06
Horse	1.10
Chicken	0.013
Donkey (adult)	0.70

Source: Storck et al. (1991)

Some appropriate test of logit model

Multi-collinearity for continuous variable

```
vif
```

Variable	VIF	1/VIF
farmlsize	1.57	0.636495
farmexp	1.57	0.638432
inc	1.05	0.955310
dfc	1.01	0.988116
liu	1.01	0.989110
Mean VIF	1.24	

Multi-collinearity for dummy variable

```
corr gen edu_l mar_s acctr acccredit accmif farmac att
obs=371)
```

	gen	edu_l	mar_s	acctr	acccre~t	accmif	farmac	att
gen	1.0000							
edu_l	0.0181	1.0000						
mar_s	0.0342	0.0419	1.0000					
acctr	-0.0243	0.1267	0.0349	1.0000				
acccredit	0.0183	0.1460	0.0210	-0.0352	1.0000			
accmif	-0.0485	-0.0006	-0.0305	-0.0141	-0.0426	1.0000		
farmac	0.0131	-0.0746	0.0168	0.0673	0.0013	-0.0237	1.0000	
att	-0.1077	0.1370	-0.0338	-0.0628	0.0730	-0.0281	-0.1044	1.0000

Heteroscedasticity test

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of age

         chi2(1)      =     0.25
         Prob > chi2  =   0.6199
```

Model specification test

```
. linktest
```

Source	SS	df	MS	Number of obs	=	371
				F(2, 368)	=	4.28
Model	2125.19154	2	1062.59577	Prob > F	=	0.0145
Residual	91295.9675	368	248.086868	R-squared	=	0.0227
				Adj R-squared	=	0.0174
Total	93421.159	370	252.489619	Root MSE	=	15.751

age	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_hat	-10.56121	9.84793	-1.07	0.284	-29.92649	8.804067
_hatsq	.1402135	.1193492	1.17	0.241	-.0944786	.3749056
_cons	237.6111	202.8256	1.17	0.242	-161.2315	636.4537

Goodness of fit test

```
. estat gof,group(10)

Logistic model for ppfc, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)

       number of observations =       371
             number of groups =        10
     Hosmer-Lemeshow chi2(8) =        10.07
                 Prob > chi2 =         0.2600
```